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The Campanian of the European palaeobiogeographical region

By

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With 1 text figure and 3 tables

ABSTRACT

Within the European palaeobiogeographical region (EPR) extending from the Atlantic coast of Europe in the west to the Transcaspian area (Mangyshlak, Ustiurt, Tuarkyr, Western Kopetdag) in the east a subdivision and correlation of Campanian deposits for separate regions are made on the basis of common complexes of fauna.

The paper gives schemes of a biostratigraphic subdivision of the stage based on macrofauna (belemnites, ammonites, certain bivalves and echinoids), as well as on microfauna for the east of the EPR (Mangyshlak, Precaspian). It should be noted that biostratigraphic boundaries based on macro- and microfauna do not coincide. We compare our subdivision schemes of the stage with the schemes of a biostratigraphic subdivision of the EPR Campanian established for the north of the GFR (G. Ernst, F. Schmid, W. Koch a. o.); at present this scheme is the most fully justified. We trace the lower limit of the Campanian at the top of beds with *Marsupites* which are well represented in Mangyshlak and at the base of the so-called "Pteria beds" of the Russian Platform. Consequently the Santonian/Campanian boundary is traced within the *Anomalina stelligera* zone as understood by Soviet micropalaeontologists and within the *Bolivinoides strigillatus* zone sensu W. Koch (1977). The Lower/Upper Campanian boundary is traced, as it is in the west of the EPR at the top of the "Quadratensenon" s. l. In other words – at the top of the *Gonioteuthis quadrata gracilis* & *Belemnellocamax mammillatus* zone. By foraminifers this corresponds to the beginning of the *Cibicidoides aktulagayensis* zone in the Russian schemes and the *Neoflabellina numismalis* zone in GFR. The replacement of *Belemnitella* by *Belemnella* gives a sharp upper boundary to the Campanian. By foraminifers this corresponds to deposits within the *Grammostomum incrassatum incrassatum* zone in the Russian scheme and the beginning of the *Neoflabellina reticulata* zone of W. Koch in the GFR.

KURZFASSUNG

Ein Korrelationsversuch der Unterstufen des Campan für die Europäische paläobiogeographische Region vom Atlantik im Westen bis zur Transkaspischen Region (Mangyshlak, Ustiurt, Tuarkyr, West-Kopetdag) im Osten wird anhand gemeinsamer Faunenkomplexe vorgestellt.

Als Zonen-Fossilien werden Belemmiten, Ammoniten, Echiniden, einige Bivalven sowie die Mikrofauna verwendet; es wird mit dem für Norddeutschland aufgestellten Schema von G. Ernst, F. Schmid, W. Koch u. a. verglichen. Die Untergrenze des Campan wird an die Oberkante der Schichten mit *Marsupites* (Mangyshlak) und an die Basis der s. g. "Pteria beds" der Russischen Tafel belegt. Somit verläuft die Santon/Campan Grenze innerhalb der *Anomalina stelligera* Zone (im Sinne der sowjetischen Mikropaläontologen) und innerhalb der *Bolivinoides strigillatus* Zone (sensu W. Koch, 1977). Die Grenze Unter-/Ober-Campan wird über der *Gonioteuthis quadrata gracilis* und *Belemnellocamax mammillatus* Zone gezogen; dies korrespondiert mit dem Beginn der *Cibicidoides aktulagayensis* Zone in den russischen Gliederungen bzw. *Neoflabellina numismalis* Zone in der norddeutschen Gliederung. Die Ablösung der *Belemnitella* durch *Belemnella* ist die scharfe Obergrenze des Campan, dies entspricht Ablagerungen innerhalb der *Grammostomum incrassatum incrassatum* Zone der russischen Gliederung bzw. dem Beginn der *Neoflabellina reticulata* Zone in Norddeutschland.

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I.

During the Late Cretaceous the seas, flooding the Russian Platform and its palaeozoic framework, made this area part of the European palaeobiogeographical region (EPR) (NAIDIN, 1969, 1979). Over the very wide areas of EPR – from its western limits at the Atlantic shores in northwestern Europe to its eastern parts in Transcaspia – lived the same organisms: belemnites, ammonites, a certain number of bivalves, echinoderms, bryozoans (VOIGT, 1964, 1967; TRÖGER, 1981). It make possible to determine using palaeontological data, to which stages the Upper Cretaceous sections of the Platform and its framework belong. More completely studied sections at present are situated in Western Europe. The very wide sublatitudinal area of EPR reflects the climatological zonation of the Late Cretaceous in Eurasia. This basic fact is proved by the settling of the Late Cretaceous marine invertebrates. The influence of regional currents on the settling of the fauna is beyond doubt; A. D. ARKHANGELSKY (1916) already stated this 65 years ago. At present, it is possible by using the distribution of typical necton organisms (belemnites) and planktonic foraminifera to come near the recognition of the phenomenon which recent oceanologists call "water mass". The combination of the sublatitudinal climatological zonation and the facts known on the currents and development of the water masses show that within the limits of the seas of EPR the settling of organisms was not the same everywhere. The character of the settling of organisms within the limits of parts of the EPR, including the Platform and the Transcaspian area is well illustrated by the biogeography of belemnites (NAIDIN, 1973, Figs 1–5). Thus, for instance, specimens of Gonioteuthis s. s. (Santonian to Lower Campanian) are far more numerous in the western part of EPR (Europe); it has been shown that only a few isolated gonioteuthids have penetrated into the northern part of the Mediterranean province. In its eastern part their distribution area wedges out in the shape of a "tongue" (Fig. 1), reaching the Don and Donetz basin. They are exceptionally rare in Crimea. This kind of feature in the distribution of Gonioteuthis s. s. does not allow to observe the Gonioteuthis Zones of the Santonian and Lower Campanian recognised in the GFR, over a large part of the Platform and the palaeozoic adjoining areas.

Another example: representatives of the genus *Belemnellocamax* (as understood by NAIDIN, 1964, but not by W. K. CHRISTENSEN, 1975 who includes *Paractinocamax* NAIDIN in *Belemnellocamax)* show a very narrow vertical distribution – limited to the top of the Lower Campanian – what would make them highly valuable for stratigraphic purposes. Unfortunately they are characterized by a relatively narrow geographical distribution (northern part of EPR: southern Sweden, Denmark, north western part of GFR, very rare in the northern part of the Anglo-Paris basin; within the boundary of the USSR: Lithuania, Volga region, Don basin and isolated guards in Eastern Precaspia and in Mangyshlak).

The irregularity of the settling of organisms can be shown by the distribution of benthonic foraminifera. Even only within the eastern EPR three groups of species can be recognised: the first with species which have a diffusion which is almost the same everywhere, the second with species which have a different stratigraphic range in different regions, the third with species which have a narrow local diffusion.

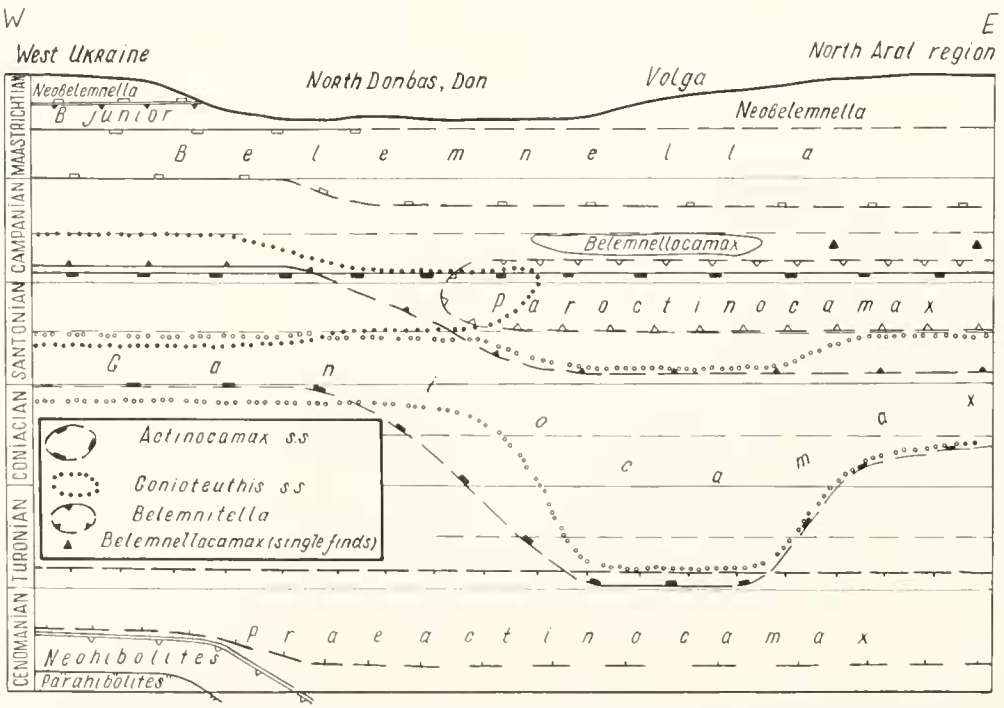


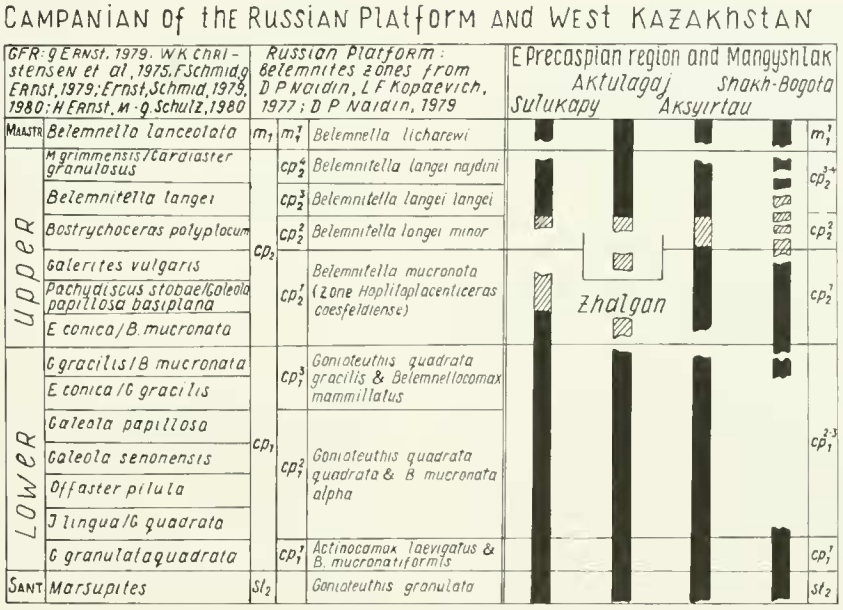
Fig. 1. Stratigraphical and geographical distribution of Late Cretaceous belemnites from eastern EPR, between Western Ukraine and northern Aral region (on latitude 50°, between 23° & 60° East of Greenwich).

II.

The article here presented brings our subdivision of the deposits of the Campanian stage based on micro – and macropalaeontological data (Tables 1–3).

A biostratigraphic subdivision for the Campanian of the Russian Platform has been published not long ago (Naidin & Kopaevich, 1977, Papulov & Naidin, 1979, Naidin, 1979). Here we focus on the Campanian deposits of most eastern parts of EPR within West Kazakhstant (Eastern Precaspian region, southeastern projection of the platform; Mangyshlak, on the palaeozoides). We obtained new data from those areas.

The stratigraphy of the Santonian stage – its boundaries and subdivision – is the least-worked-on Upper Cretaceous interval in our territory. This is due to a row of circumstances of which the two principal are: the rarity of organic remains in this stratigraphic interval and bad outcrops on a significant part of EPR (Russian Platform, Crimea). In the well exposed outcrops of Mangyshlak the Santonian is also poor in fossils. However, in the section of Shakh-Bogota, the Upper Coniacian beds with *Inoceramus involutus* Sowerby are directly overlain by beds containing remains of *Inoceramus indulato-*



Russian Platform		West Kazakhstan (Eastern Precaspian region and Mangyshlak)	
m_1^1	*Belemnella licharewi*	m_1^1	*Belemnella licharewi*
cp_2^4	*Bostrychoceras polyplocum, Trachyscaphites pulcherrimus, T. spiniger, Anapachydiscus wittekindi, Pachydiscus oldgami*	cp_2^{3-4}	*Belemnitella langei najdini*
cp_2^3	From bottom to top: *B. langei minor* (cp_2^2), *B. langei langei* (cp_2^3), *B. langei najdini* (cp_2^4)		*Belemnitella langei langei*
cp_2^2		cp_2^2	*Belemnitella langei minor*
cp_2^1	*Hoplitoplacenticeras coesfeldiense, Hopl. vari, Trachyscaphites (?) gibbus, Neancyloceras phaleratum, Belemnitella mucronata mucronata*	cp_2^1	*Hoplitoplacenticeras coesfeldiense, Pachydiscus cf. stobaei, Trachyscaphites spiniger, B. mucronata mucronata* Below: *Inoceramus azerbaidjanensis*
cp_1^3	*Belemnellocamax mammillatus* (NE), *Gonioteuthis quadrata gracilis* (SW), *Belemnitella mucronata mucronata*	cp_1^{2-3}	*Paractinocamax* ex. gr. *grossouvrei, B. mucronata alpha, Micraster schroederi, Offaster pilula* Above: *Belemnellocamax mammillatus*
cp_1^2	*Gonioteuthis quadrata quadrata* (SW), *Belemnitella mucronata alpha*		
cp_1^1	*G. quadrata quadrata, G. granulata quadrata* (SW), *Actinocamax laevigatus, B. praecursor media, B. pr. mucronatiformis, Paractinocamax grossouvrei, Oxytoma tenuicostata*	cp_1^1	*Act. laevigatus, B. praecursor media, B. pr. mucronatiformis, Paractinocamax grossouvrei pseudoalfridi, Offaster pilula, Micraster schroederi, Oxytoma tenuicostata* (Precaspian region)
st_2	*Gonioteuthis granulata* (SW)	st_2	*Marsupites testudinarius* (Mangyshlak) *Uintacrinus socialis* (Mangyshlak)

SW, NE = South-Western and North-Eastern parts of EPR within the Russian Platform

	Beds with foraminifera (West Kazakhstan)	Foraminiferal zonation: V. P. Vassilenko (Mangyshlak)	Foraminiferal zonation: W. Koch (GFR)
m_1^1	*Angulogavelinella gracilis:* *An. gracilis, Cibicidoides bembix, Neoflabellina reticulata, Osangularia navarroana*	*Grammostomum incrassatum incrassatum*	*Neoflabellina reticulata*
cp_2^{3-4}	*Brotzenella taylorensis:* *Br. taylorensis, Bolivina incrassata incrassata, Neoflabellina praereticulata*	*Cibicides voltzianus: Cb. voltzianus, Grammostomum kalinini, Anomalina cayexi, Cibicides orcinus, Bolivinoides draco miliaris*	*Bolivinoides draco miliaris: Bl. draco miliaris, Bolivina incrassata incrassata, Neoflabellina praereticulata*
	Bolivina kalinini: *B. kalinini, Bolivinoides draco miliaris, Gemmelides orcinus*		
cp_2^2	*Cibicidoides voltzianus:* *Orbignyna inflata, Cb. voltzianus, Gavelinella clementiana laevigata, Globorotalites emdyensis*		
cp_2^1	*Brotzenella monterelensis:* *Orbignyna ovata, Or. sacheri, Br. monterelensis, Br. menneri*	*Cibicides aktulagayensis: Cb. aktulagayensis, An. monterelensis, Or. sacheri*	*Neoflabellina numismalis: N. numismalis, Bolivinoides laevigatus*
cp_1^{2-3}	*Cibicidoides aktulagayensis:* *Cb. aktulagayensis* *Cibicidoides temirensis:* *Cb. temirensis*	*Cibicides temirensis: Cb. temirensis, Cb. aktulagayensis* (above), *Stensioeina pommerana*	*Bolivinoides decoratus: Bl. decoratus, Bl. granulatus, Neoflabellina rugosa*
	Bolivinoides decoratus: *Ataxophragmium compactum caspium, Bl. decoratus, Bl. granulatus, Osangularia cordieriana*		
cp_1^1	*Gavelinella clementiana clementiana:* *G. clementiana clementiana, Gavelinella dainae, Stensioeina pommerana, Neoflabellina rugosa*	*Anomalina stelligera. Anomalina stelligera, A. costulata.* above: *Anomalina clemantiana clementiana, Bolivinoides strigillatus*	*Bolivinoides strigillatus. Stensioeina granulata granulata, St. granulata perfecta;* above: *Gavelinella clementiana, Stensioeina pommerana, Bolivinoides strigillatus*
st_2	*Gavelinella stelligera:* *Ataxophragmium orbygnynaeformis, G. stelligera, Bolivinoides strigillatus*		
	Osangularia		

plicatus Roemer, a species characteristic for the Lower Santonian Zone of Western Europe. The upper Santonian boundary in Mangyshlak we consider to be very clearly expressed. It consist of a double macropalaeontological horizon of only a few metres: the lower part contains remains of *Uintacrinus socialis* Grinnell, the upper part plates, arms and even complete thecae of another crinoid, *Marsupites testudinarius* (Schlotheim). This horizon we place in the Upper Santonian of the three-membered subdivision of the stage used in Western Europe; so far, we cannot divide the lower Santonian deposits in the lower and middle members of that same subdivision. In the section without hiatus of Shakh-Bogota we consider the Santonian to begin with the beds of *I. undulatoplicatus* and at the top are the first appearance of *Uintacrinus;* thus we define the Lower Santonian. We have written previously (Akimetz et al., 1979; Naidin & Ivannikov, 1980) that in Mangyshlak it is advisable to put the boundary between the Santonian and the Campanian at the top of the *Marsupites* beds. This placement would be in accordance with the understanding of the larger part of the researchers working on lithologically, palaeontologically and biostratigraphically well documented sections in the Santonian and Campanian of the GFR. We consider that the sections in GFR are fulfilling those requirements. Substantiation of such a placement of the Santonian/Campanian boundary can be found in the paper by Papulov & Naidin (1979, pp. 7–23). Clearly, indeed the placement of the Santonian/Campanian boundary at the top of *Marsupites* beds, based solely on macropalaeontological data, has a real possibility of becoming one of the accepted Upper Cretaceous boundaries. The outcrops at the stratotypes, as shown in the article of Akimetz et al. (1979: 119) do not help to solve the question of this boundary.

Not long ago, Wood (1981) after studying the sections from North England (Yorkshire, Lincolnshire, Norfolk) and Northern Ireland also put the Santonian/Campanian boundary at the top of the Marsupites beds.

According to foraminiferal data this boundary lies within the deposits of the *Anomalina stelligera* zone s. l. (Vassilenko, 1961; Trifonov & Vassilenko, 1963) and within the *Bolivinoides strigillatus* zone (Koch, 1977). A more detailed subdivision into three members has been published recently (Akimetz et al, 1979) and has been followed in the present work (Table 3). According to this subdivision the boundary falls within the *Gavelinella stelligera* beds.

On the Russian Platform the position of the Santonian/Campanian boundary has been usually related to the position of the "*Pteria* beds" (the beds containing *Oxytoma (Pteria) tenuicostata* (Roemer)). This is one of the basic problems of the Upper Cretaceous stratigraphy of the Platform. Remains of pteriids have a wide and massive distribution and can even be seen in borehole cores. In this way the *Pteria* beds have acquired the significance of an important stratigraphic marker. Some new data on the problem of the *Pteria* beds have recently been published (Akimetz et al., 1978, 1979; Papulov & Naidin, 1979; Naidin & Ivannikov, 1980). Those data prove that the *Pteria* beds belong to the beginning of the Campanian; they prove that the correlation used by a series of authors of those beds with the *Marsupites* beds cannot be upheld. The *Marsupites* beds, as has been shown above, forms the top of the Santonian, and consequently they are stratigraphically lower than the *Pteria* beds of the platform.

Our data on the distribution of benthonic foraminifera allow a more precise correlation between the *Marsupites* beds of Mangyshlak and the *Pteria* beds of the Precaspian region.

The interval of the section called "*Pteria* beds" of the Russian Platform is equivalent to the *Gavelinella clementiana clementiana* beds (upper part of the *Anomalina stelligera* zone), resting directly on the *Gavelinella stelligera* beds (Table 3).

In Mangyshlak full sections between the *Marsupites* beds and the *Gavelinella clementiana clementiana* beds a 2–4 m thick sequence (the topmost part of the *Gavelinella stelligera* beds) is recognisable. Very probably this sequence corresponds with that recognised in Southern England immediately above the deposits with the last *Marsupites* – the beds with *Uintacrinus anglicus* (Brydone) Rasmussen (Rasmussen, 1961; Mortimore, 1981). According to Mortimore (1981: 12) their thickness is about 2–3 m.

Koch (1977) places the lower boundary of the Campanian stage within the deposits of the *Bolivinoides strigillatus* zone, slightly lower than the first appearance of *Gavelinella clementiana* and *Stensioeina pommerana*, which in our understanding correlate with the lower boundary of the *Gavelinella clementiana clementiana* beds.

In Mangyshlak the Campanian is represented mainly by chalks, chalky marls and marls (thikness 70–200 m). Hardground surfaces are common.

In the Eastern Precaspian region the deposits of this stage are specific marls, offen pyritised; their thickness is 150–250 m.

The Campanian deposits in Mangyshlak and in the Eastern Precaspian region contain rare belemnite guards and ammonites. Using those the Campanian of both regions can be biostratigraphically subdivided; the resulting subdivision can be compared with that used in GFR, in Western Ukraine, in the Dnieper-Donetz basin and in the Volga region (Table 1).

A very important part of the Campanian fauna of Mangyshlak are the echinoderms. Remains of asteroids, ophiuroids are not rare, in places crinoids are common, but especially abundant are the echinoids. However only a few representatives of the echinoids and crinoids have significance for the subdivision of the sections and for their correlation with other regions.

The lower Upper Campanian (cp_2^1) contains few macrofossils; therefore, the boundary between the substage is based on foraminifera. It lies at the beginning of the *Brotzenella monterelensis* beds. If we apply different micropalaeontological subdivisions, the boundary is situated at the beginning of *Cibicidoides aktualagayensis* zone (Vassilenko, 1961; Trifonov & Vassilenko, 1963) or at the *Neoflabellina numismalis* Zone (Koch, 1977).

The uppermost Upper Campanian can be subdivided in subzones using subspecies of *Belemnitella langei* which correlates with foraminiferal beds (Tables 2, 3). The upper boundary of the Campanian in the eastern part of EPR is strongly expressed: from massive finds of *Belemnitella* species of the group *langei* there is a sudden (in the sections there is no hiatus visible) turnover into *Belemnella* species (Table 2). Applied to foraminifera this means that this turnovers point lies within the *Angulogavelinella gracilis* beds. In the Vassilenko scheme 1961 the boundary is placed in the lower part of the *Grammostumum incrassatum incrassatum* zone; Koch (1977) places it at the beginning of the *Neoflabellina reticulata* zone.

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